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Case report

Posterior rib fractures as a cause of delayed aortic injury: A case series and literature review☆

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SUMMARY

Multiple rib fractures are common in blunt thoracic trauma, and while indicative of the severity of injury, are rarely implicated as the solitary cause of death. Significant chest wall injury and the presence of flail chest is associated with substantial dysfunction and morbidity, including the need for respiratory support, pneumonia or septicemia, and prolonged hospitalization and pain medication requirements [12]. Posterior rib fractures are commonly associated with flail segments, but are often minimally displaced due to surrounding soft tissue attachments and support. However, if associated with intrathoracic displacement, the risks of significant morbidity and even mortality increase exponentially, and surgical intervention is indicated to minimize this risk.

Review of the literature produced one case report describing a posterior rib fracture causing aortic injury and subsequent mortality [13]. However, we were able to find an additional ten patients who had successful treatment of this injury pattern [1–3,5–10,14].

The purpose of this report is to describe the circumstances of this unique case and review the existing literature on this topic. This will highlight the importance of attention to the posterior chest wall, as negligence of this injury pattern can prove to be fatal.

1. Case report

A healthy 50-year-old male presented to our level one trauma centre after his tractor rolled over his chest and abdomen. He was initially evaluated at an outside emergency department prior to arrival; at the outside facility, he received intravenous volume resuscitation, intubation and left chest tube thoracostomy for a hemopneumothorax. Upon arrival at our facility, he quickly became hypotensive and resuscitation continued with further intravenous fluids and blood products. His overall blood pressure improved with further addition of pressors, but remained somewhat labile.

The patient's initial chest radiograph showed multiple rib fractures on the left along with a left scapular body fracture (Fig. 1). Computed tomography (CT) of his chest further delineated his injuries, revealing fractures of the left first through eleventh ribs with segmental fractures of the second through tenth ribs (flail segment). Also of note, the posterior fragments of the seventh and eighth ribs were found to be impressing directly upon the aorta (Fig. 2a and b). The chest CT also showed a comminuted left scapular body fracture, multiple thoracic spine fractures and a grade 3 pulmonary injury.

The patient's secondary survey revealed a 6-centimetre laceration over the left medial malleolus and subsequent radiographs showed a bimalleolar ankle fracture. Orthopaedic surgery was then consulted at that time for management of the open ankle injury and rib fractures. Unfortunately, due to the patient's haemodynamic lability, elevated lactate and base excess, immediate operative management of his open ankle injury was initially delayed. He was resuscitated overnight and was optimized for surgery by the following morning; he underwent irrigation and debridement of his open wound as well as open reduction and internal fixation of his ankle fracture at that time. He remained hemodynamically stable throughout the procedure and was returned to the intensive care unit postoperatively.

On the following day, he continued to maintain an average mean arterial pressure of approximately 70 mmHg. In addition, his lactate had normalized and his base deficit was nearly corrected. The plan at this time was to proceed with open reduction and internal fixation of his flail chest and rib injuries the following day, assuming restoration of resuscitation parameters.

☆ This work was conducted at Grant Medical Center, Columbus, Ohio, USA.

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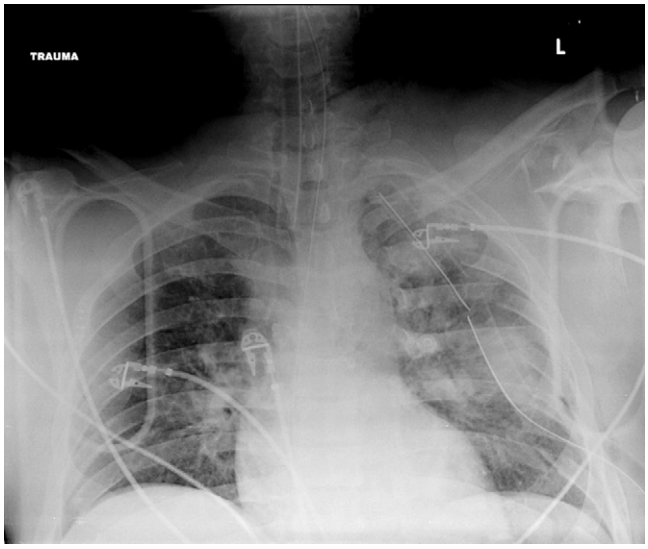

Fig. 1. Portable chest radiograph showing multiple left sided rib fractures and a left scapular body fracture.

Later in that same morning, the patient awakened, indicated difficulty breathing, bit down on his endotracheal tube, and went into cardiac arrest. Electrocardiographic monitoring noted ventricular tachycardia, which was defibrillated into PEA. His thoracotomy tube began to drain a copious amount of hematogenous drainage, and an emergent bedside thoracotomy was performed. After incising the pleura, a large amount of active bleeding was encountered; upon deep initial inspection, the heart was noted to be empty and there was minimal cardiac activity. The site of injury was discovered as the posterior aorta, and direct communication with the posterior rib fracture was seen. Due to continued lack of cardiac activity and ventricular filling despite aortic cross clamping and other resuscitative measures, the patient was finally pronounced dead and all life-saving efforts discontinued.

2. Discussion

Multiple rib fractures are common after blunt chest injury and are an indicator of the risk of mortality from associated lung or solid organ injury [4]. Aortic injury is also well described as a result of blunt chest trauma resulting from a rapid deceleration injury. However, rib fractures are rarely implicated as a direct cause of mortality.

In our review of the literature we found only one case describing a posterior rib fracture which caused aortic injury and subsequent mortality [13]. However, there are ten case reports which describe the successful treatment of this injury pattern [1–3,5–10,14]. Table 1 provides a summary of the details of the cases found in our literature review. In all but one of the cases treated successfully, patients had an initial period of stability with a sudden decompensation ranging from day 2 to day 15 after injury. In two patients, the sudden decompensation was noted after positional change in bed [1,14]. In all cases, the injured ribs were left-sided posterior rib fractures, involving the fifth to ninth rib. Notably, only six of eleven patients were noted have a true flail segment.

The predominant mainstays of rib fracture management are: adequate pain control, aggressive pulmonary toilet and ventilatory support when needed. In cases of flail chest, chest wall deformity, persistent pain, rib fracture nonunion and in patients undergoing thoracotomy for other reasons, operative stabilization of fractured

Table 1
Summary of published cases.

Author	Age	Gender	Identification of aortic threat/injury	Approach	Aortic injury description	Threatening or lacerating rib(s)	Aortic repair	Rib treatment	Patient outcome
Ashrafian et al.	52	Not reported	Day 11	Thoracotomy	"Puncture"	Not reported	Primary suture repair	Not reported	Uneventful recovery
Bruno et al.	87	Male	Day 6	Thoracotomy	3 mm laceration	Left 8th	Direct suture	Fragment excised	Uneventful recovery
Faneyte et al.	56	Male	Day of injury	Endovascular	Not reported	Inferior left rib (not specifically identified)	GORE TAG endovascular graft	None reported (thoracotomy 2 weeks later)	Uneventful recovery
Iyoda et al.	66	Male	Day 15	Thoracotomy	8 mm laceration	Left 9th rib	Primary repair	Resected sharp rib fragments	Uneventful recovery
Kabiri et al.	24	Female	Day of injury	Thoracotomy	Not reported	Left 9th/10th	Covered by parietal pleura (adventitial lesion only)	Partial rib resection	Uneventful recovery
Kern et al.	57	Male	Day of injury	Thoracotomy	5 mm laceration	Left 5th lacerating, 4th & 6th threatening.	Prolene pledgeted suture reinforced with gore-tex patch.	Resected sharp rib fragments	Uneventful recovery
Kigawa et al.	37	Male	Day 10	Thoracotomy	Not reported	Left 8th rib	Not reported	Sharp edges debrided	Uneventful recovery
Kitamura et al.	63	Male	Day 2	Thoracotomy	4 mm puncture	Left 7th rib	Prolene pledgeted suture	Resection of fractured rib	Uneventful recovery
Marco et al.	36	Male	Day 3	Thoracotomy	Not reported	Left 6th rib lacerating. 5th rib threathening	Prolene pledgeted suture	Sharp edges debrided and covered with bone wax	Uneventful recovery
Tsai et al.	65	Female	Day of injury	Thoracotomy	Not reported	Not reported	None	None	Mortality
Yanagawa et al.	57	Male	Day 5	Thoracotomy	2 "puncture" injuries, a few mm each	Left 6th and 7th	Not reported	Rongeured and ORIF	Concommitant C7 spinal cord injury required prolonged rehabilitation

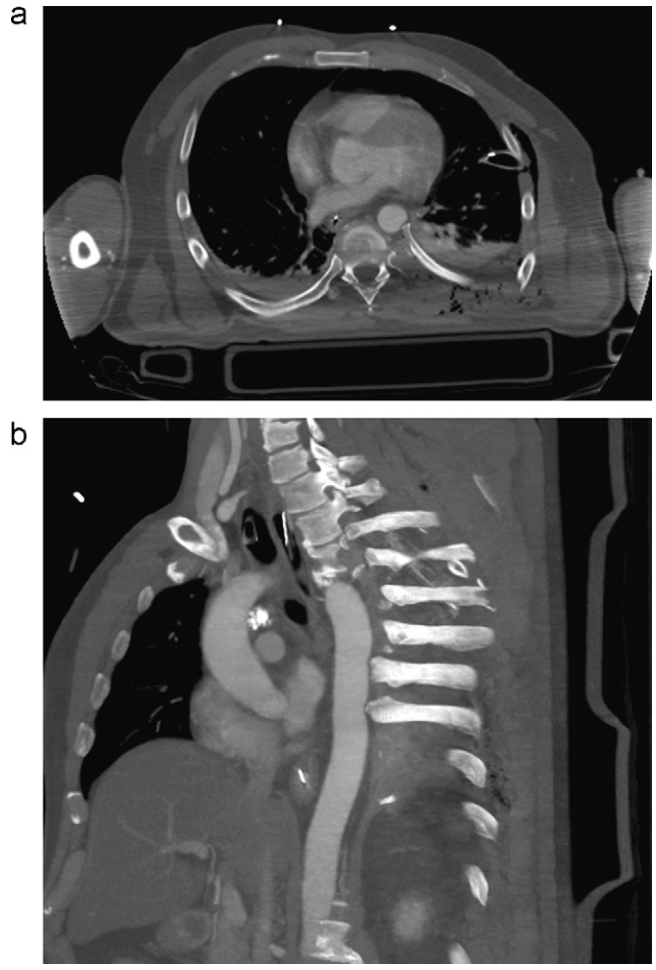

Fig. 2. a and b: (a) Axial CT cut showing a displaced fragment of the seventh rib impressing upon the aorta and (b) sagittal CT cut showing fragments of the sixth and seventh ribs impressing upon the aorta.

ribs may be indicated, and the orthopaedic trauma, cardiothoracic, or general trauma surgeon familiar with chest wall reconstruction may be consulted.

Our patient and the aforementioned additional cases highlight several important factors to consider when managing patients with left sided posterior rib fractures. In all eleven cases, the fractures were noted at the time of initial evaluation, but in nine of eleven, acute decompensation from aortic injury occurred in a delayed fashion. An additional case report describes successful prevention of impending aortic injury by stabilization of a flail chest. This highlights the importance of early recognition of left posterior rib fractures and the possibility of successfully preventing aortic injury with early operative intervention. In patients who have already sustained aortic injury it is reasonable to stabilize their rib fractures at the closure of the thoracotomy in order to prevent further injury and to protect the aortic repair. Finally, it is important to consider the potentially unstable nature of these injuries and the possibility of aortic injury with patient positional changes or overly aggressive manipulation of fracture fragments at the time of surgery.

3. Conclusions

Aortic injury from posterior rib fractures is a rare, but life threatening occurrence. Early involvement of the appropriate surgeon with early fracture stabilization has the potential to prevent this complication.

Conflict of interest statements

Dr. Boyles has no financial or other conflicts to disclose.

Dr. Taylor has received research grant support from Synthes and the Orthopaedic Trauma Association, is on the speaker's bureau for Synthes, and is an editorial board member of Orthobullets.com.

Dr. Ferrel has no financial or other conflicts to disclose.

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